They say that there is another species of Salmon that comes in the fall, having transverse dark spots, large teeth, and nose largely curved, but it does not turn red or but little at most. I will give the name and consider it in place of the "Dog Salmon."

4th. Spotted Fall Salmon,* "*O-le-arah*" (accent on first syllable).

5th. Steel-head,† "*Quan-nesho*" (accent last syllable).

I have been unable to give the right sound in English to the last syllable of the last name. The above is as near as I can make it.

There is another salmon which you did not mention. It comes in the last of the summer run; it is as large if not larger than the spring salmon, but of a darker color and not so fat.

It will make number—

6th.‡ "*Ek-ul-ba*" (accent first syllable).

REMARKS UPON THE OSTEOLOGY OF OPHEOSAURUS VENTRALIS.

By Dr. R. W. SHUFELDT, U. S. A.

(Read before the Biological Society of Washington, D. C., December 23, 1881.)

Guided, to a great extent, by external characters, modern herpetologists, in the arrangement of our American reptiles, have assigned this lizard to the genus *Opheosaurus*, of the family *Anguidæ*, of the suborder *Diploglossa*. This arrangement brings it very near the genus *Gerrhonotus*, a lizard with which I have osteologically compared it. The external characters are referred principally to the form and disposition of the scales, the presence in *Gerrhonotus* of a ventral line, and the position of the external ear.

Opheosaurus ventralis inhabits the entire Austroriparian region, Tennessee, Kansas, and several of the Middle States. It is found lurking in the woods in damp places, frequently burrowing under ground, and is at all times a gentle and harmless lizard. We all know that in common parlance *Opheosaurus* has been termed the Glass Snake, from the fact that when a moderate blow is delivered it, it usually parts with a portion of its tail, the fracture sometimes taking place at one or more points. These ruptures, and they always occur from violence, are invariably postanal, and the part lost is susceptible of reproduction from the locality at which the fracture took place in the lizard's body. Interesting as this part of the natural history of our subject is, it does not rightfully come within the limits of a paper devoted to its osteology,

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* *Oncorhynchus keta* (Walb.) G. & J.

† *Salmo gairdneri* Rich.

‡ *Oncorhynchus chouicha* (Walb.) J. & G. (Fall run: "Ekewan" of Richardson.)

and I will be obliged to dismiss this characteristic in *Opheosaurus* here by simply calling the attention of the student to the fact that, as far as my studies have carried me, it appears that true caudal vertebræ are never reproduced in the new tail, be it only a portion or the entire appendage is lost, but in their place we have substituted a series of semi-osseous nodules, that eventually form the bony core to the new part.

The opportunity has not been afforded me to enter very extensively into the occurrence of bone in the exoskeleton of this lizard, but Professor Owen tells us (Anat. of Verts., vol. i, p. 555) that "bone is developed at the base of the scale, forming part thereof, or combining scute and scale, in *Ophisaurus*, *Tribolonotus*, and *Trachysaurus*." We may add to this that there certainly seems to be more or less bone tissue, be it semi-osseous or otherwise, in the tough and brittle plates that overlie the true skull, superiorly. It requires but a very superficial examination of the skull of this snake-like lizard to satisfy the zoötomist that he has before him a creature that, so far as this part of its bony framework is concerned, at least, makes a very near approach to the typical Lacertilian, an indication that is more than likely to be carried out in other parts of its anatomy.

We find the occipital condyle to be uniform in outline, being notched above, with its long axis placed transversely; it stands out quite prominently from the lower margin of the elliptical foramen magnum, which in turn has its long or major axis parallel with the axis of the condyle; prominent though this latter may be, it cannot be said to be pedunculated, but really is sessile, its prominence being greatly due to the segments that support it. The part that the basi- and exoccipitals took in its formation is plainly indicated even in the adult by delicate little furrows that mark the boundaries of the original segments.

This condition of the condyle obtains in many of our American lizards, notably in *Gerrhonotus* and in *Sceloporus* and kindred forms among the *Iguanidæ*. Substantial protection is afforded the brain below by the perfect union that has taken place among the bones of the basis cranii, the basisphenoid, basioccipital with the exoccipitals, which latter support tuberous and outstanding paroccipitals. On the other hand, the anterior wall of the brain-case depends solely in the living animal upon thin membranous partions for the defense of the encephelon, the representatives of the ali- and orbitosphenoids. This open space in the articulated cranium is bounded below by the basisphenoid and laterally by the parotic on either side. Above we again find the brain completely guarded by osseous plates, which here are the united parietals, that in turn become indistinguishably amalgamated with the large superoccipital. Mesiad, the united parietals anchylos with the parotics of the brain-case, while anteriorly these bones articulate suturally with the hinder borders of the frontals; no parietal foramen ever existing at this point as found in some lizards. Laterally, each parietal is extended backwards in a diverging limb, that on either side articu-

lates throughout its entire margin with the squamosal overlapping the latter at its termination and abutting against the lateral process of the occipital. In their course these wings of the parietals bend downwards by a gentle curve, which is more abrupt in the shorter skull of *Gerrhonotus*.

The interfrontal suture is persistent, and these bones form the mid-plates at the top of the skull; taken together the plate is narrower behind than it is in front, where it meets the nasals, while on either side it articulates with the lacrymal and postfrontal; a limited portion of this margin being free, it enters into the formation of the superior moiety of the periphery of the orbit. In our *Holbrookia maculata* among the *Iguanidæ* we find this interorbital portion of the frontal plate crowded to a mere osseous and median line by the immense orbits. The nasals have united medially just as the frontals have, and they, being now anteorbital, are allowed to curve downwards on either side to meet the maxillaries, while anteriorly they form the upper and posterior margin of either nostril, and receive between them in the middle line the posterior process or nasal process of the premaxillary. This latter bone forms the rounded anterior end of the skull; it also completes the nostril in front and below, this subcircular aperture having its border or periphery eventually made entire by the assistance of the maxillary on either side, it filling in the lower and posterior part. This portion of the skull is formed in a like manner in *Eumeces*, but in this genus the termination of the cranium anteriorly is more acute, being blunter and broader in *Gerrhonotus scincicaudus*. We will complete this view of the cranium by calling attention to the longitudinal foramen that exists anteriorly between the squamosal and parietal on either side.

The lateral aspect of the skull (Fig. 1) presents for examination quite a number of interesting points. We have, posteriorly, a free *os quadratum* that stands as a protecting pillar at the portals of the auditory meatus. This bone has a quadrilateral outline in front, nearly flat, while behind it is deeply concave throughout its length, and supports below an oblong facet, placed transversely for a similar shaped articulating surface on the lower maxilla. Above it is very much expanded, antero-posteriorly, the hinder part of which surface is occupied by the end of the squamosal. This form of the *os quadratum* (*o. q.*, Fig. 1) obtains in *Gerrhonotus* and *Eumeces*, and in fact seems to be but slightly departed from by the vast majority of our lizards. Between the anterior boundary of the *os quadratum* and the posterior boundary of the orbit, and the arching squamosal above that meets both points, there is exposed to view in the skull of this lizard, and, I believe, in all of its congeners, through an open space here existing, the delicate

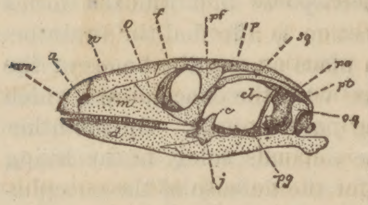

Fig. 1.

little *columella* (*cl.*, Fig. 1), that has its superior end abutting against the under surface of the parietal, while its lower rests in a circular socket intended for it, on the upper surface of the middle of the pterygoid. Its lower articulation is anterior to its upper, *i. e.*, the bone leans backwards.

In all of the American lizards that I have examined this bonelet is constant, and Professor Huxley tells us in his Anatomy of Vertebrated Animals, page 219, that "In the principal group of the *Lacertilia*, a column-like membrane bone, called the *columella* (but which is not to be, by any means, confounded with the *stapes*, to which the same name is often applied in reptiles), extends from the parietal to the pterygoid on each side, in close contact with the membranous or cartilaginous wall of the skull. Hence they have been called "*Kionocrania*" or "column skulls."

Through this open space we also have lateral views of the pterygoids and the basisphenoid with the parotic and pro-otic bones above and immovably articulated with the latter. There seems to be a small separate ossification wedged in between the squamosal and parietal behind, articulating with the exoccipital and *os quadratum*, that seems to correspond with Professor Huxley's *pterotic.* In the dried skull it is not movable.

The orbit is bounded by three bones: above by the frontal, as already described; anteriorly by the *lacrymal*, that articulates with the jugal by a descending process, anteriorly with the maxillary, nasal, and frontal; while the *postfrontal* and *jugal* bound its posterior moiety, the former bone articulating above with the frontal and parietal, below and posteriorly with the jugal and squamosal, and the latter, the *jugal*, by its anterior process with the lacrymal, by its posterior with the postfrontal and squamosal; thus we see that the orbital periphery is complete. The skull is completed laterally by the *maxillary;* this bone bears teeth in its alveolar process below, articulating with the bones that go to form the roof of the mouth internally, while, upon the aspect of the skull we now have under consideration, it articulates behind with the lacrymal and jugal, above with the nasal, anteriorly with the premaxillary.

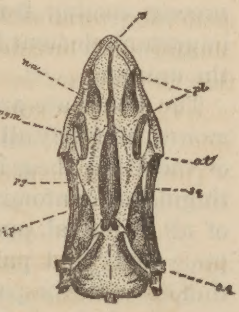

Fig. 2.

The prefrontal fulfills its customary function in constituting in part an osseous septum narium, meeting the ordinary segments as they are arranged in the Lacertilian skull.

Passing to the base of the cranium (Fig. 2), we find the basisphenoid giving off, near its anterior termination, or the base of the rostrum in some vertebrates, on either hand, well-developed *pterapophysial processes* that have dilated extremities to articulate with longitudinally-elongated facets upon the pterygoids. These latter bones form one of the principal features of the basis cranii; they extend backwards, con-

verging outwards from the points where they articulate with the processes of the sphenoid, to articulate by movable joints at the anterior and lower angles of the quadrate bones; anteriorly they develop horizontal plates that articulate in front with the palatines, laterally by a process that, on either side, meets the *os transversum*. Their upper surfaces form the greater part of the floor of the orbit, while on their under surfaces they present for examination on either bone a longitudinal row of minute conical teeth, the row being double behind and produced anteriorly so that a few of them are found upon the palatines beyond. The palatines complete the roof of the mouth distally, leaving between them quite an extensive palatine fissure that ceases when it meets the vomer where that bone dips down to lend its aid in establishing the septum narium. A palatine starting from the oblique pterygoidal articulation proceeds forwards by a rather broad horizontal plate that, as it comes opposite the maxillary, throws off an external and lateral process to meet that bone and close in the "nasal aperture" behind; it then turns inwards to the commencement of the palatine fissure, to proceed by a much broader plate that bounds the nasal aperture internally, and only terminates by quite an extensive articulation with the maxillary laterally, and with the premaxillary and vomer anteriorly, curling outwards to complete the aforesaid nasal vacuities. On either side an *os transversum* is found; this little bone is wedged in between the maxillary and jugal on its outer side, while it articulates with a process coming from the palatine on its inner, thus forming quite an important element in completing the floor of the orbit and the base of the cranium.

The bones are arranged at the base of the cranium and roof of the mouth, in nearly all lizards, so as to encircle and bound certain foramina or vacuities; these have been described by Owen and named by that distinguished anatomist as, first, the "interpterygoidal vacuity," the largest of all, a mesial, open, elliptical space in our subject bounded by the pterygoids and palatines laterally, the basisphenoid behind, and continuous with the palatine fissure anteriorly; the next, being parial, are the "pterygo-maxillary" vacuities; these occur on either side, and are bounded laterally by the maxillary and os transversum, internally by the pterygoid and palatine; while, finally, we have the "nasal apertures," bounded on their outer sides by the maxillaries, behind and internally by the palatines. In *Gerrhonotus*, the skull being broader, these apertures are consequently wider; otherwise the general arrangement of the bones at the base of the skull is the same. In examining the eye, we discover the *sclerotals* to be present, as they are in *Aves*. They are quadrate in outline, slightly overlapping each other, and number from eighteen to twenty in the average number of specimens examined.

The rami of the lower maxilla are turned outwards, so that the alveola processes are the most external; this condition is so much increased after we pass the coronoid bones that the sides of the jaw become nearly

horizontal. They terminate by quadrate plates that tend to approach the median plane, these horizontal plates protruding in the articulated skull back of the articular facets and the quadrate bones. Broadly oblong, and raised above the general level of the bone, the articular facets look upwards and a little backwards and outwards. The *coronoid bones* are placed, one on either side, slightly posterior to the middle point of the ramus; they project upwards and backwards as laterally-compressed processes that show externally still fairly-developed traces of their original sutures; upon this aspect, also, we observe the irregular sutural line, indicating the point of ending of the dentary portion of the maxilla.

Fig. 3.

Each ramus is perfectly smooth beneath, being gently convex from side to side, broadly so longitudinally. The external curve about the symphysis is parabolic in outline, the inner being sharply acute, and, passing backwards as the inferior ramal border, maintains a more or less parallel position with the external or alveolar border. Anchylosis is never thoroughly established between the dentary elements at the symphysis, this joint having an articulation very similar to the symphysis pubis of anthropotomy, the interested bones coming apart upon very slight provocation in the dried skeleton, showing each articular face to be roughened for an amphiarthrosial joint.

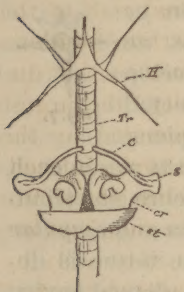

Fig. 4.

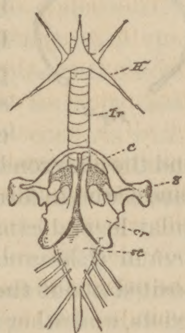

Fig. 5.

In the specimens that I have examined, the teeth in the upper jaw seem to invariably pass completely round the alveolar process, while in the lower jaw a few always seem to be lacking on either side of the symphysis; this is also the case in *Gerrhonotus*, but not so in a specimen of *Eumeces skiltonianus*. These teeth are of the *pleurodont* type; in other words, they are anchylosed to an outer alveolar plate, as in many of the *Iguanidæ*. Above their points of union to the alveolar process they are conical in form, pearly white, and glistening, being arranged in a row of some seventeen to twenty in each ramus, the largest being found in the middle and the smallest at either end. The *hyoidean arch* seems to be largely cartilaginous in structure, though a good deal of bone tissue does exist in it, particularly about the center. In form it resembles the capital letter X, the upper limbs being directed forwards and outwards, the hinder ones backwards and outwards; the body of the hyoid occupying the intersection as an equilateral triangle, with one of the angles placed anteriorly in the middle line, and from which is produced a delicate "glosso-hyal"; the posterior limbs springing from its outer angles, and the anterior ones, apparently by articu-

lation, from midpoint of its sides. *Gerrhonotus* has a hyoidean arch very similar to the one found in *Opheosaurus*.

In the largest and best specimen that was examined, there were found 147 vertebræ with a series of caudal nodules where a tail had been replaced; there were 52 pairs of ribs, and this number was also found in a smaller specimen. The atlas is characteristic of the usual Lacertilian type, and a stumpy odontoid process is found upon the axis. Free vertebral ribs are not exhibited until we have passed backwards for three or four segments, but when the series commences it is continuous to within one vertebra of the rudimentary pelvis, and even this intervening segment may develop a small free pleurapophysis. These ribs have rounded bodies with laterally compressed and dilated extremities below; the pair when articulated lie in the curve of a broad ellipse that sustains the shape of this lizard's body. They articulate by feebly developed capitula, at the base of the diapophyses, at the very anterior margin of the centrum of each vertebra, in concave facettes placed there for their accommodation. Commencing with the atlas, the first two or three vertebræ support hypapophyses, that are at first directed downwards, then directly backwards in a sharp point; it is with this segment, too, that the quadrate neural spine makes its appearance, to be continued throughout the chain, past the pelvis; to become directed more and more backwards, and more pointed as we pass through the caudal series.

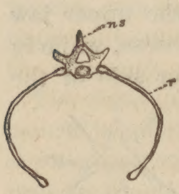

Fig. 6


Fig. 7.

Well-developed pre- and post-zygapophyses are found upon the neural arches of all of the vertebræ, and the cup and ball socket between the centra is ellipsoidal in form and placed transversely on the bone, being concave in front, convex behind. The neural tube, beginning more or less triangular, becomes subelliptical as we pass posteriorly. Caudal vertebræ develop sharp, spine-like diapophyses, that are directed outwards at right angles with the neural spines and the chevron bones below, which latter in these segments are in each case a wedge-formed hypapophysis, attached to each vertebra, the triangular hæmal canal passing through them all. The *sternum* and *scapular arch* in *Opheosaurus* is largely cartilaginous, though bone tissue is deposited about the points, where in the higher lizards the glenoid cavity exists, and other localities where additional strength is required. So far as my examinations have extended I have thus far failed to discover the presence of a rudimentary pectoral limb; even the very semblance of the glenoidal socket appears to be missing. The clavicles do not meet in the median line, but their outer extremities articulate with the expanded blade of the scapula on either side, which latter bone is semiosseous only. A transverse plate, covering the lower borders of the coracoids, is the sole representative of a sternum. The entire apparatus is placed immediately over the trachea, while the outer and expanded blades of the scapulæ lap over the first and second pleurapophyses.

Taken as a whole we could hardly look for a better example of a rudimentary apparatus throughout, even to its minor details. In *Gerrhonotus*, all of the points that are so feebly developed in *Opheosaurus* have been carried to a still higher point, and one approaching the true Lacertilian type, and although in this lizard the anterior and posterior limbs are present, they are weaker than in other forms, such as the *Iguanidæ*. In *Gerrhonotus* the clavicles meet mesiad, and the coracoids articulate with elongated facets upon a semi-osseous sternum, that has inserted along its sides the hæmapophyses that articulate above with the dorsal ribs. Passing next to the examination of the pelvis, we find that although some parts have been more or less suppressed or have almost passed beyond recognition, we still find a rudimentary femur present. The fifty-seventh vertebra has suspended from its diapophyses, and articulating freely with their extremities, two spoon-shaped bones, one on either side; these do not meet in the median line, but are separated by a space of several millimeters. The dilated extremity of each is below, and from the middle point on the outside surface, rotating in a diminutive acetabulum, we find the rudimentary femur, represented by a minute cylinder of bone, rounded at both extremities. A faint sutural line passing through this cotyloid-cavity indicates the division between the ilium above and the puboischium below. Professor Mivart found this condition in some of the forms he examined, and he tells us in his Lessons in Elementary Anatomy, page 195, that "confining ourselves, therefore, for purposes of comparison, to Mammals, Sauropsida, and Batrachians, we find the femur under a certain aspect more constantly present than the humerus. For although it is often absent when the humerus is present (as in forms like Siren, which have pectoral limbs but no pelvic ones), yet it is sometimes present in a more or less rudimentary condition when no representative of the foot coexists with it. Such is the case, *e. g.*, in some whales (as the Greenland whale) amongst mammals, and certain snakes, *e. g.*, *Boa*, and certain lizards, *e. g.*, *Lialis*, amongst the reptiles."

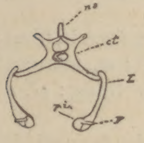

Fig. 8.

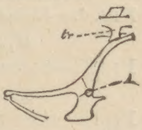

Fig. 9

In *Gerrhonotus* all three of the pelvic bones go to form the acetabulum, the pubic elements curving far anteriorly as delicate osseous columns to meet, mesiad, in a common cartilaginous articulation. The arch is suspended in a like manner from the transverse processes of a vertebra.

Though a little foreign to our subject, it will be of interest to many to know something of the character of food of this lizard, and in this Professor Riley has kindly assisted me, and sends the following diagnosis of a stomach that I sent him:

"The contents of stomach of *Opheosaurus ventralis* consists almost entirely of fragments of a tolerably common spider, *Lycosa ruricola* Hentz, with a single small black seed and seed-pod of some plant, not determinable on account of condition."

Dr. Vasey kindly examined the seed and thinks it may be a *Heliocharis*, but is not certain. Unfortunately, the writer has not had the opportunity, from lack of material, of examining such a form as *Barissia olivacea*, a lizard that Cope has placed as the leading genus under *Gerrhonotidæ;* as far as our examination has gone, however, of forms representing other genera, it should leave no doubt as to the soundness of the classification in placing our apodal *Opheosaurus* in the niche it now occupies.

EXPLANATION OF FIGURES.

FIG. 1.—Left lateral view of skull of *Opheosaurus ventralis*, life size: *pm.*, premaxillary 1, nostril; *n.*, nasal; *m.*, maxillary; *l.*, lacrymal; *f.*, frontal; *pf.*, postfrontal; *p.*, parietal; *sq.*, squamosal; *po.*, pro-otic; *pt.*, pterotic; *o. q.*, *os quadratum;* *cl.*, columella; *c.*, coranoid; *d.*, dentary; *j.*, jugal; *pg.*, pterygoid.

FIG. 2.—Skull of *Opheosaurus ventralis* seen from beneath, taken from a smaller specimen than Fig. 1, and enlarged: *v*, vomer; *pl.*, palatine; *o. t.*, *os transversum; sq.*, squamosal; *o. q.*, *os quadratum; n. a.*, nasal aperture; *pgm.*, pterygomaxillary vacuity; *pg.*, pterygoid; *ip.*, interpterygoid vacuity.

FIG. 3.—Lower jaw of *Opheosaurus ventralis*, life size, same specimen as Fig. 1, seen from above: *c.*, coronoid; *a. f.*, articular facet.

FIG. 4.—Hyoid and scapular arch of *Opheosaurus ventralis*, life size, seen from in front: *H*, hyoid; *Tr.*, trachea; *c.*, clavicle; *s.*, scapula; *cr.*, coracoid; *st.*, sternum.

FIG. 5.—Same from *Gerrhonotus scincicaudus*, letters indicate the same thing: *gl. c.*, glenoid cavity.

FIG. 6.—Anterior view of vertebra, with its ribs, from *Opheosaurus ventralis*, from middle of spinal column; *n. s.*, neural spine; *r.*, rib.

FIG. 7.—Anterior view of caudal vertebra from same specimen.

FIG. 8.—Anterior view of vertebra that bears the pelvic arch, *O. ventralis*, slightly enlarged: *n. s.*, neural spine; *ct.*, centrum; *I.*, ilium; *p. i.*, pubo-ischium; *F.*, rudimentary femur.

FIG. 9.—Sketch of lateral view of pelvis of *Gerrhonotus scincicaudus*, slightly enlarged: *tr.*, transverse process of vertebra; *A.*, acetabulum.

ON CERTAIN LIMPETS AND CHITONS FROM THE DEEP WATERS OFF THE EASTERN COAST OF THE UNITED STATES.

By W. H. DALL.

I have received from Professor Verrill certain limpets or patelliform shells and chitons collected under his supervision off the southeast coast of New England in deep water by the United States Fish Commission parties in 1881, with his kind permission to describe them. Though without particular beauty and of small size, the hope that these specimens would prove of interest has not been disappointed.

Limpets are generally shore or shallow water mollusks; the connection of certain peculiarities of structure in them with their geographical distribution, and the progressive development indicated by the characters of different genera, have already been the subject of comment by me.*

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* Sci. Results of the Expl. of Alaska, I, art. II, pp. 41–43, 1876.